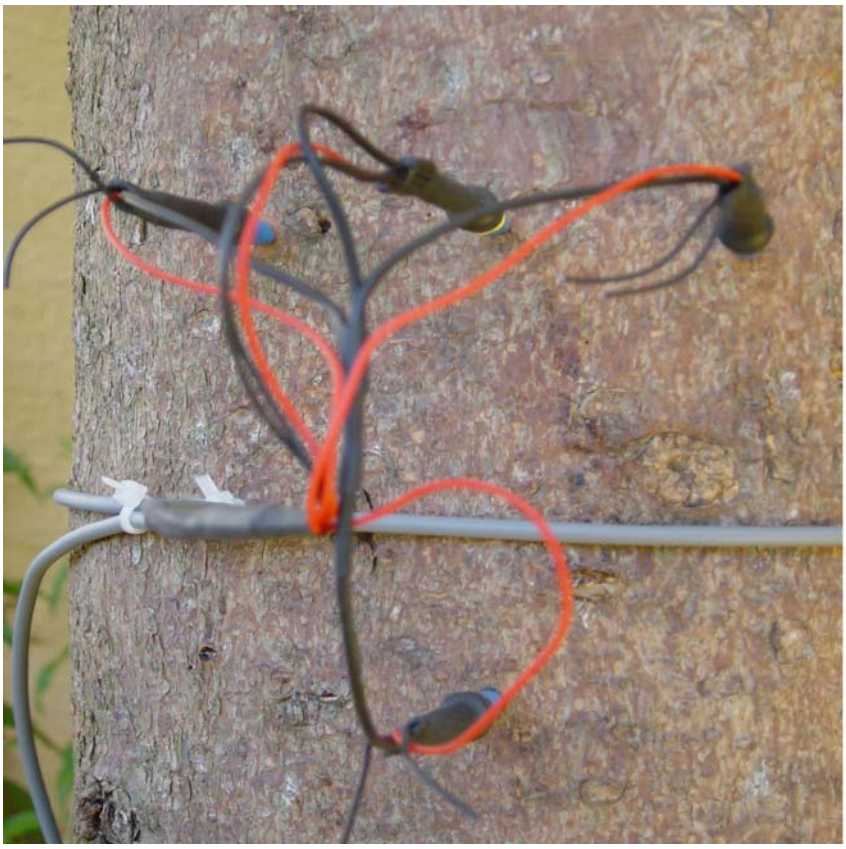
Sapflow-Measurement



Sapflow Sensor Typ SF-L

Improved Graniers principal according Dr. Liu
based on four temperature points

UP Umweltanalytische Produkte GmbH * Bockradenerstrasse 52b * D-49477 Ibbenbüren * HRB 6800
Tel: +49/5451/502-222 * Fax: -333 * email: s.schweighoefer@upgmbh.com * www.upgmbh.com * www.sapflow.com

Theory of the Transpirationflux

The sap flow transports nutrients to the leaves and to active cells (LARCHER 1984). The big water-potential difference between the soil, the plant and the atmosphere as well as capillar power cause the sap flow from the roots to the leaves (ASKENEY, JOLY,DIXON1894/95).

Transpiration depends on the water-potential in the leaves and meteorological parameters (Wind, Radiation, Humidity and Temperature) as well as on soil moisture. Sap flow/Transpiration starts in the early morning hours and has maximum values about midday. At predawn hours sap flow is almost null. Measuring sap flow is a key technique in understanding and regulating plant water relations.

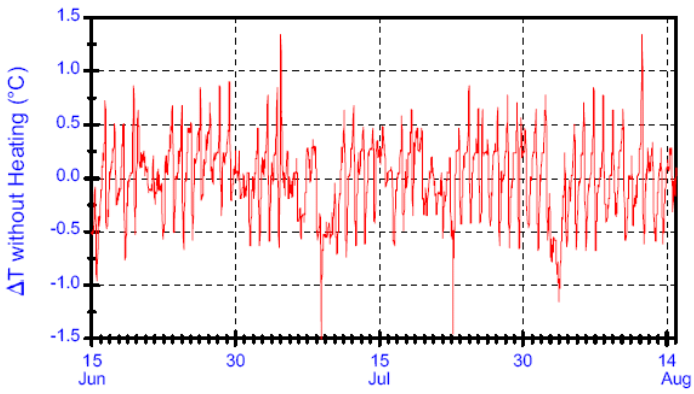
Why to improve Granier's principle

The well known Granier sap flow sensor, i.e. thermal dissipation probe (Granier, 1985) is to use heat as a tracer in the sap. Due to its simplicity, reliability and affordability, numerous scientists have used the Granier technique all over the world.

However, the technique has always had some shortcomings, these include:

1). Granier technique determines arbitrarily the sap flow to a zero value every night. This contravenes the possibility of nighttime transpiration (Granier, 1987) and the refilling process of tree body during the night. (Do and Rocheteau, 2002).

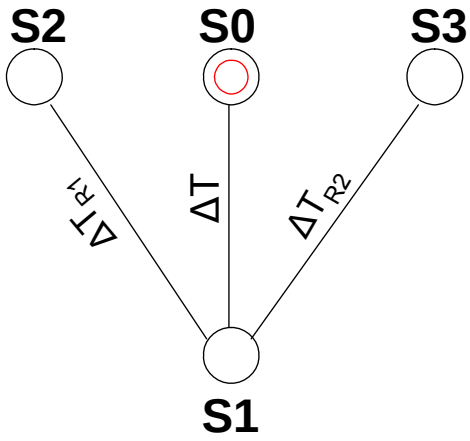
2). The technique ignores the effect of natural temperature gradients of the sap-wood being measured, which range between +/- 1.5 °C and can cause considerable error in the results (DO and Rocheteau, 2002).

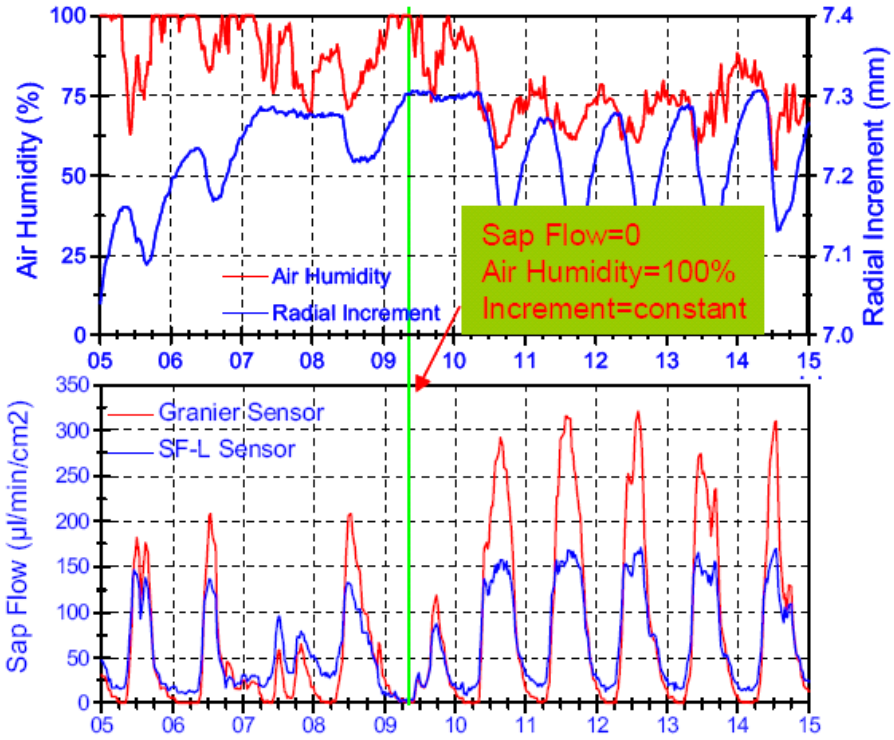


The SF-L sensor takes into consideration the variations of the natural temperature gradients of sapwood. The sensor uses two reference thermocouples to continuously record background temperature gradients (ΔTR1, ΔTR2) of the sapwood. During data processing, values of the temperature differences between the heated needle and the sapwood ambient temperature (ΔT) are corrected by the ΔTR1, ΔTR2.

2. Principle of Measurement

The new sensor therefore considerably enhances flow measurements through continuous correction of natural temperature gradients of the sapwood. In contrast to Graniertechnique, SF-L sensor provides a very stable and more accurate ΔTmax_value (temperature difference between the heated needle and the sapwood ambient temperature when sap flow=0). ΔT_max_value is dependent on sap flow and is attained under conditions of zero transpiration and zero tree body refilling. This means 100% air humidity and zero tree diameter expanse. The diameter changes are detectable with high accuracy dendrometer (see figure below).





Above: Air humidity and radial changes of 40 years old spruce tree measured with a dendrometer type DD. Increase in diameter at night indicates that the tree continues to take up water even during night-time hence sap flow continues until the beginning of transpiration in the next morning.

Below: Comparison between sap flow measured with Granier sensor (red line) and with SF-L sensor (blue line). The Granier sensor shows zero sap flow every night while the SF-L detects zero value only on the night of 9. July, when air humidity reached 100% and the treebody fully saturated with water.

Sapflow-Measurement

Data acquisition

Any Datalogger, which is able to measure µV Signals with a resolution of at least 10µV, i.e. 0.25 °C (copper-constantan-thermocouples), can be used to record the readings. Note: You need 3 differential channels to connect one SF-L Sensor.

UP offers a wide range of suitable Dataloggers to measure Sapflow Sensors like

- Skye datahogs (1-16 channels)
- Delta-T logger type DL-2e (15 - 60 channels)
- UP PROSALOG (professional Sapflow Logger including integrated constant current source and interrupted heating option)
- MIRo² (MultiInterfaceRecorder to Log up to 50 SDI-Channels + 3 sapflow Channel or up to 50 Analogue-SDI-Interfaces resulting in total of 200 analogue channels)

For the conversion of microvolts into temperature you can use a mean value of 40µV per degree Celsius - if you do not measure the ambient temperature you will have to do this anyway.

NOTE: To run sapflow sensors you need a constant current source for temperature stable heating of the yellow marked needle.

We offer a special constant current source which provides the required heating perfor-mance (84mA constant current output, temperature stabilised!). You can connect max. 3 heated needles to one ccs2.

UP Umweltanalytische Produkte GmbH,
D-49477 Ibbenbüren, Germany
Phone:+49/5451/505-222
Fax: +49/5451/505-333
Email: s.schweighoefer@upgmbh.com

Distributor: